DEPARTMENT OF NATIONAL DEFENCE
CANADA

OPERATIONAL RESEARCH DIVISION

DIRECTORATE OF OPERATIONAL RESEARCH (JOINT & LAND)

DOR(J&L) RESEARCH NOTE RN 9914

SCENARIO OPERATIONAL CAPABILITY RISK ASSESSMENT MODEL (SOCRAM) – PRESENTATION TO THE CANADIAN OPERATIONAL RESEARCH SOCIETY (CORS) CONFERENCE '99 AT WINDSOR ONTARIO, 8 JUNE 1999

BY

R.W. Funk

OCTOBER 1999

OTTAWA, CANADA

National Defence Défense nationale

102-02312/

OPERATIONAL RESEARCH DIVISION

CATEGORIES OF PUBLICATION

ORD Reports are the most authoritative and most carefully considered publications of the DGOR scientific community. They normally embody the results of major research activities or are significant works of lasting value or provide a comprehensive view on major defence research initiatives. ORD Reports are approved personally by DGOR, and are subject to peer review.

ORD Project Reports record the analysis and results of studies conducted for specific sponsors. This Category is the main vehicle to report completed research to the sponsors and may also describe a significant milestone in ongoing work. They are approved by DGOR and are subject to peer review. They are released initially to sponsors and may, with sponsor approval, be released to other agencies having an interest in the material.

Directorate Research Notes are issued by directorates. They are intended to outline, develop or document proposals, ideas, analysis or models which do not warrant more formal publication. They may record development work done in support of sponsored projects which could be applied elsewhere in the future. As such they help serve as the corporate scientific memory of the directorates.

ORD Journal Reprints provide readily available copies of articles published with DGOR approval, by OR researchers in learned journals, open technical publications, proceedings, etc.

ORD Contractor Reports document research done under contract of DGOR agencies by industrial concerns, universities, consultants, other government departments or agencies, etc. The scientific content is the responsibility of the originator but has been reviewed by the scientific authority for the contract and approved for release by DGOR.

DEPARTMENT OF NATIONAL DEFENCE

CANADA

OPERATIONAL RESEARCH DIVISION

DIRECTORATE OF OPERATIONAL RESEARCH (JOINT & LAND)

DOR(J&L) RESEARCH NOTE RN 9914

SCENARIO OPERATIONAL CAPABILITY RISK ASSESSMENT MODEL (SOCRAM) – PRESENTATION TO CANADIAN OPERATIONAL RESEARCH SOCIETY (CORS) CONFERENCE '99 AT WINDSOR ONTARIO, 8 JUNE 1999

by

R.W. Funk

Recommended by: _____ Approved by: _____

G.L. Christopher
SPORT

G. Lafond
DOR(J&L)

Directorate Research Notes are written to document material which does not warrant or require more formal publication. The contents do not necessarily reflect the view of ORD or the Canadian Department of National Defence.

OTTAWA, ONTARIO

OCTOBER 1999

ABSTRACT

One of the major tasks in developing the Scenario-Based Capability-Planning Framework in the Strategic Planning Operational Research Team (SPORT) is to ensure the rigorous activation of concurrent events. After a review of methodologies it was decided to pursue the development of the Scenario Operational Capability Risk Analysis Model (SOCRAM), a discrete event simulation to assess the cumulative demand imposed by the distribution of activated scenarios.

This report covers the content of a background briefing on SOCRAM that was given to the Canadian Operations Research Society Conference at Windsor Ontario on 8 June 1999. It also serves as one of the documents recording the developmental history of a component of the Force Planning Scenario Framework.

RÉSUMÉ

Pour l'Unité de recherche opérationnelle en planification stratégique (UROPS), une des principales tâches que comporte l'élaboration du cadre de planification des capacités fondée sur des scénarios est d'assurer que les événements simultanés sont activés avec la plus grande exactitude. Après un examen approfondi des méthodologies, il a été décidé de poursuivre la mise au point du Modèle d'analyse des risques de capacité opérationnelle fondée sur des scénarios (MARCOS), une simulation à événements discrets permettant d'évaluer les pressions cumulatives causées par la distribution de scénarios activés.

Ce rapport résume la matière d'un exposé général sur MARCOS donné pendant la conférence de la Société canadienne de recherche opérationnelle qui s'est tenue le 8 juin 1999 à Windsor (Ontario). Ce rapport a également un usage documentaire puisqu'il enregistre l'évolution d'un élément du cadre de la planification des forces fondée sur les scénarios.

TABLE OF CONTENTS

ABSTRACT I

RÉSUMÉ I

TABLE OF CONTENTS II

LIST OF FIGURES III

I – INTRODUCTION 1

BACKGROUND 1

II - PRESENTATION 2

OPENING REMARKS 2

MODELING OF THE PROBABILITIES 5

OVERVIEW OF SOCRAM 7

EXAMPLE OF HOW CAPABILITY IS CALCULATED 10

PRESENTATION OF CAPABILITY RESULTS 12

EXAMPLE OF HOW FORCE OPTIONS ARE CALCULATED 16

PRESENTATION OF FORCE ELEMENT RESULTS 18

FUTURE ISSUES AND INTENTIONS 20

CONCLUSIONS 22

LIST OF FIGURES

SLIDE 1 : TITLE SLIDE 2
SLIDE 2 : CAPABILITY ANALYSIS PROCESS 3
SLIDE 3 : BACKGROUND OF SOCRAM 4
SLIDE 4 : EXPECTED ITERATIONS BETWEEN # OF SCENARIOS ACTIVATED .. 5
SLIDE 5 : PARETO DIAGRAM OF THE # OF SCENARIOS ACTIVATED 6
SLIDE 6 : OVERVIEW OF SOCRAM PROCESS 7
SLIDE 7 : CONCURRENCE ANALYSIS ORGANIZING CONCEPTS 8
SLIDE 8 : HIERARCHY OF SOCRAM TERMINOLOGY 9
SLIDE 9 : EXAMPLE OF FEASIBLE COMMITMENTS 10
SLIDE 10 : EXAMPLE OF FEASIBLE CAPABILITIES 11
SLIDE 11 & 12 : RISK OF CUMULATIVE DEMAND FOR CAPABILITIES 12
SLIDE 13 & 14 : RISK OF NORMALIZED DEMAND FOR CAPABILITIES 14
SLIDE 15: EXAMPLE OF FEASIBLE FORCE OPTIONS 16
SLIDE 16 : EXAMPLE OF VIABLE FORCE OPTIONS 17
SLIDE 17 : RISK OF CUMULATIVE DEMAND FOR FORCE ELEMENTS 18
SLIDE 18 : RISK OF NORMALIZED DEMAND FOR FORCE ELEMENTS 19
SLIDE 19 : PHASING OF CONCURRENT DEMANDS 20
SLIDE 20 : STATUS OF SOCRAM AND INTENTIONS 21
SLIDE 21 : QUESTIONS 22

SCENARIO OPERATIONAL CAPABILITY RISK ASSESSMENT MODEL (SOCRAM)

I – INTRODUCTION

BACKGROUND

1. One of the major tasks in developing the Scenario-Based Capability-Planning Framework in the Strategic Planning Operational Research Team (SPORT) is to ensure the rigorous activation of concurrent events. After a review of methodologies it was decided to pursue the development of the Scenario Operational Capability Risk Analysis Model (SOCRAM), a discrete event simulation to assess the cumulative demand imposed by the distribution of activated scenarios.

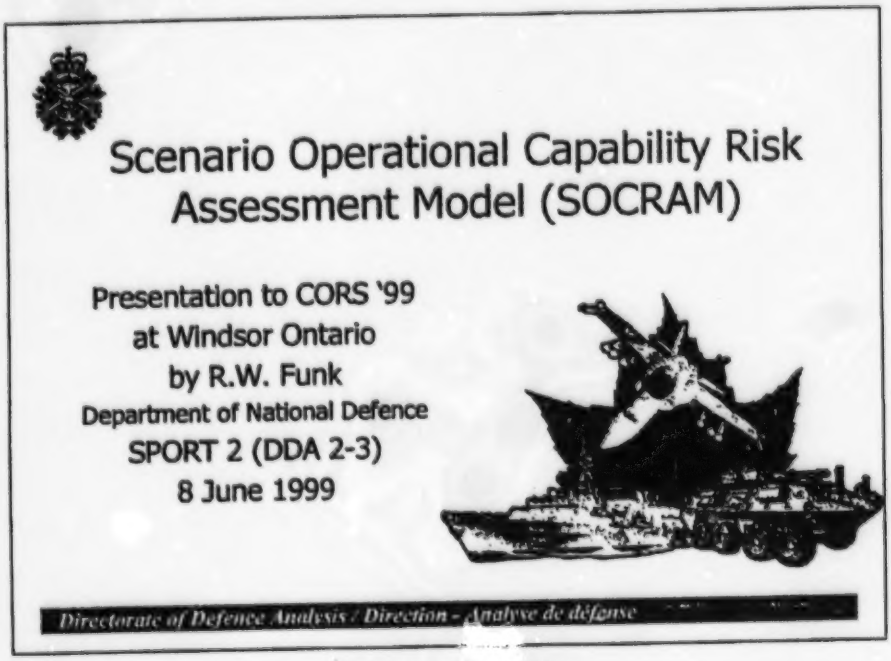
2. This report covers the content of a background briefing on SOCRAM that was given to the Canadian Operations Research Society Conference (CORS'99) at Windsor Ontario on 8 June 1999. The briefing was a significant turning point in the evolution of SOCRAM because it was the first time that the fully developed data structure and scenario activation process were brought together. The presentation provided an excellent venue for a comprehensive discussion of SOCRAM with scientific peers. The model's attributes and issues were illuminated for the first time through a "toy" problem and the details discussed have been incorporated in detailed explanations accompanying each slide.

3. The CORS '99 presentation also consolidated the SOCRAM methodology into the form upon which a long anticipated proof-of-concept trial of the Force Planning Scenario (FPS) Framework was to be conducted. As such, it is a noteworthy document recording a key developmental aspect in the history of the FPS Framework.

4. It is the author's intention to combine this document with the lessons learned from the proof-of-concept trial into a more fully developed document that will then become the methodological basis for the full-scale implementation of SOCRAM.

II - PRESENTATION

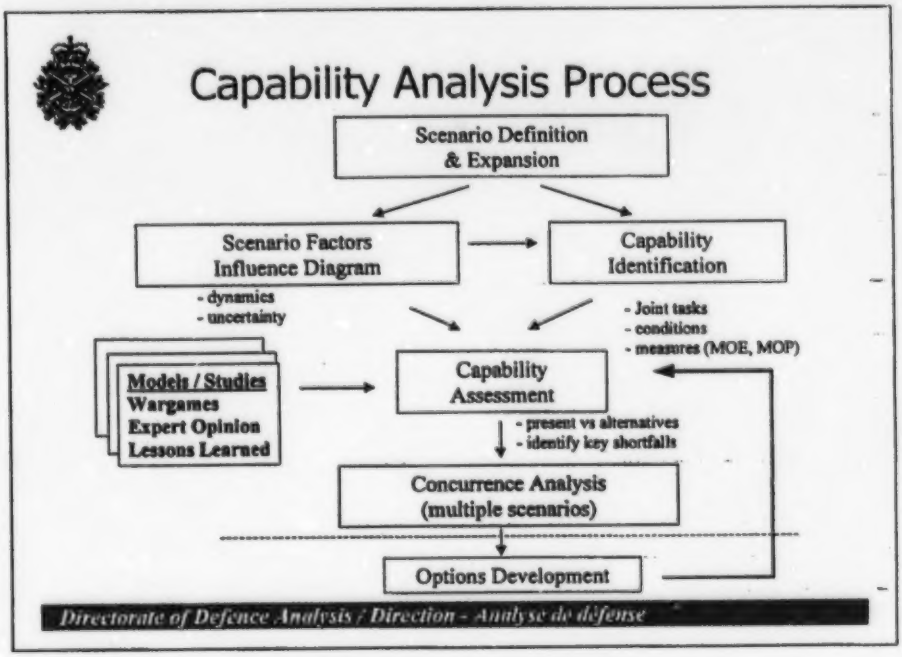
OPENING REMARKS


Scenario Operational Capability Risk Assessment Model (SOCRAM)
Presentation to CORS '99
at Windsor Ontario
by R.W. Funk
Department of National Defence
SPORT 2 (DDA 2-3)
8 June 1999
Directorate of Defence Analysis / Direction - Analyse de défense

Slide 1 : Title Slide

5. This presentation was prepared for the Canadian Operational Research Society (CORS) to brief the Scenario Operational Capability Risk Assessment Model (SOCRAM). It was presented at the CORS Annual Conference in Windsor Ontario on 8 June 1999.

6. This briefing covers the final analysis component of the Capability Analysis Process being developed by the Strategic Planning Operational Research Team (SPORT) within the Director Defence Analysis (DDA) for the Director General Strategic Planning (DGSP).

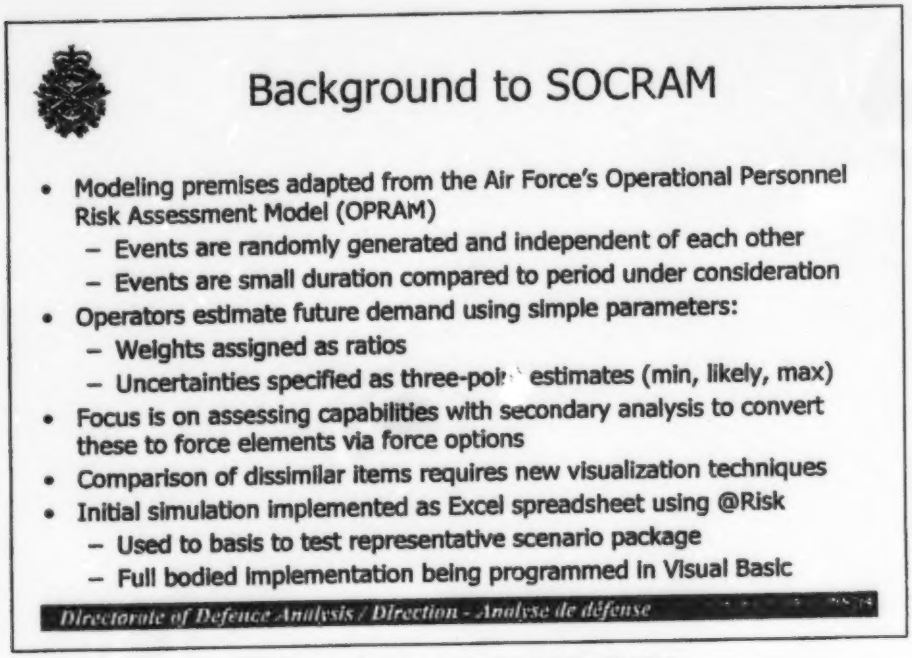


Slide 2 : Capability Analysis Process

7. The DGSP Force Planning Scenario Project has a Track III - Methodology Development phase, which is developing the specific set of tools to deal with each component and integrate them into a comprehensive Capability Analysis Process (CAP).

8. CAP is designed to ensure all aspects of capability requirements are rigorously considered. It starts with the definition and expansion of a scenario. Next, each scenario's factors and influences are articulated, along with identification of existing capabilities. These are then pulled together into a formal capability assessment that draws upon the most applicable models and studies available to ensure each scenario has been thoroughly analyzed.

9. The final step in CAP is a rigorous Concurrence Analysis which is really a reality check to ensure the cumulative impact of multiple scenarios are properly considered. This presentation focuses on the conceptual framework and operational implementation of the Concurrence Analysis.


Background to SOCRAM
• Modeling premises adapted from the Air Force's Operational Personnel Risk Assessment Model (OPRAM)
– Events are randomly generated and independent of each other
– Events are small duration compared to period under consideration
• Operators estimate future demand using simple parameters:
– Weights assigned as ratios
– Uncertainties specified as three-poi estimates (min, likely, max)
• Focus is on assessing capabilities with secondary analysis to convert these to force elements via force options
• Comparison of dissimilar items requires new visualization techniques
• Initial simulation implemented as Excel spreadsheet using @Risk
– Used to basis to test representative scenario package
– Full bodied implementation being programmed in Visual Basic
Directorate of Defence Analysis / Direction - Analyse de défense

Slide 3 : Background of SOCRAM

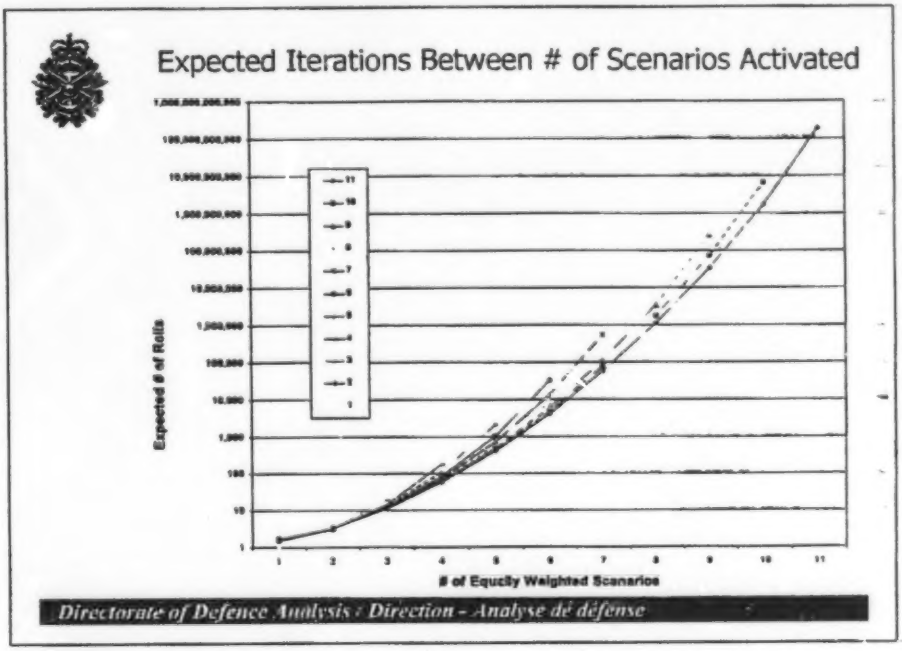
10. The SPORT implementation of uncertainty and concurrence issues that arise from the Capability Analysis Process is referred to as the Scenario Operational Capability Risk Assessment Model (SOCRAM). It is a new model but draws much of its intellectual property from the knowledge accumulated in the development and fielding of the Air Force's Operational Personnel Risk Assessment Model (OPRAM) between 1994 - 1998.

11. The basic premise of SOCRAM is that maximum future demand can be approximated by simulating the interaction of simple planning parameters. The extensive sampling of the future is used to develop a distribution function that describes the exposure to risk. SOCRAM mimics the major planning considerations used to activate a mix of scenarios and leaves the activation details to the individual analyses.

12. The SOCRAM framework provides a simple but rigorous framework to make sensible estimates plus articulate the planning uncertainties. The most significant hurdle that SOCRAM had to overcame was how to compare conceptual capabilities despite the lack of any common metric. (OPRAM only had to consider establishment and personnel).

13. SOCRAM has been successfully implemented in a spreadsheet format. It is being tested against a representative situation while a full-bodied solution is being programmed in Visual Basic.

MODELING OF THE PROBABILITIES


Expected Iterations Between # of Scenarios Activated
Expected # of Rolls
# of Equally Weighted Scenarios
Directorate of Defence Analysis / Direction - Analyse de défense

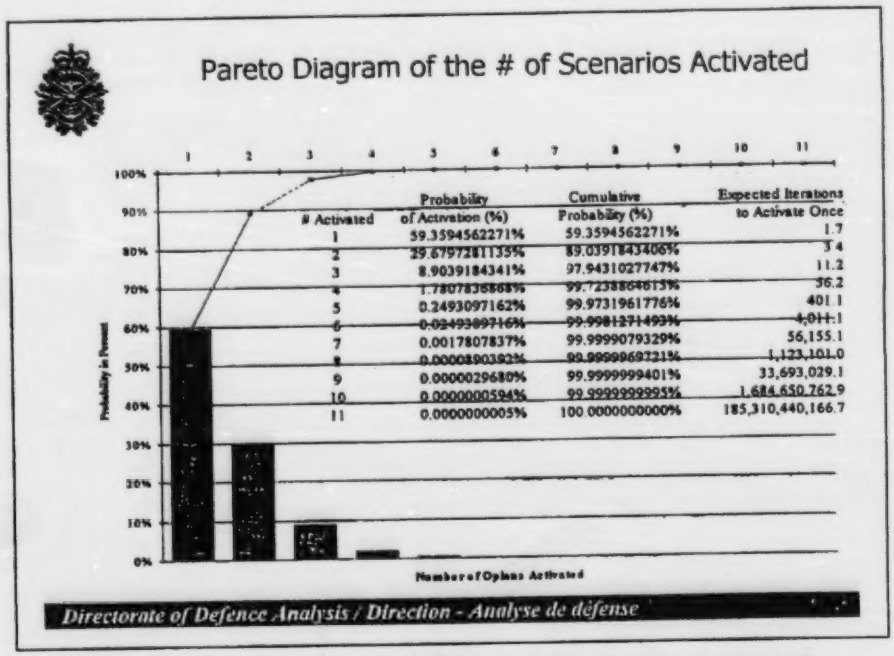
Slide 4 : Expected Iterations Between # Of Scenarios Activated

14. In order to understand the scope and complexity of the scenario concurrence problem it is essential to understand the underlying dynamics of how demand accumulates.

15. Most discussions about scenario planning implies that the probability of activating all eleven scenarios concurrently is approximately the same as activating any other combination. The implication of this is that the Department must dedicate resources to each scenario independently, whatever the cost, or abandon that commitment altogether.

16. The reality is not so clear cut. As the slide indicates, only a relatively low number of scenarios will ever be activated simultaneously. This trend applies irrespective to number of scenarios in a pool, even in cases where a large pool exists to draw upon. Since this is the case, the risk of the simultaneous activation of most or all scenarios takes on a miniscule value. In essence, the number of scenarios specifies the number of dice to throw plus the number of faces on each.

17. The consequence of rare simultaneous activation is that the volume of assets required decreases significantly if decision-makers are willing to accept a small amount of risk. Keep in mind this exists prior to factoring in the ability of decision-makers to prioritize tasks and limit their responses to the available resources.

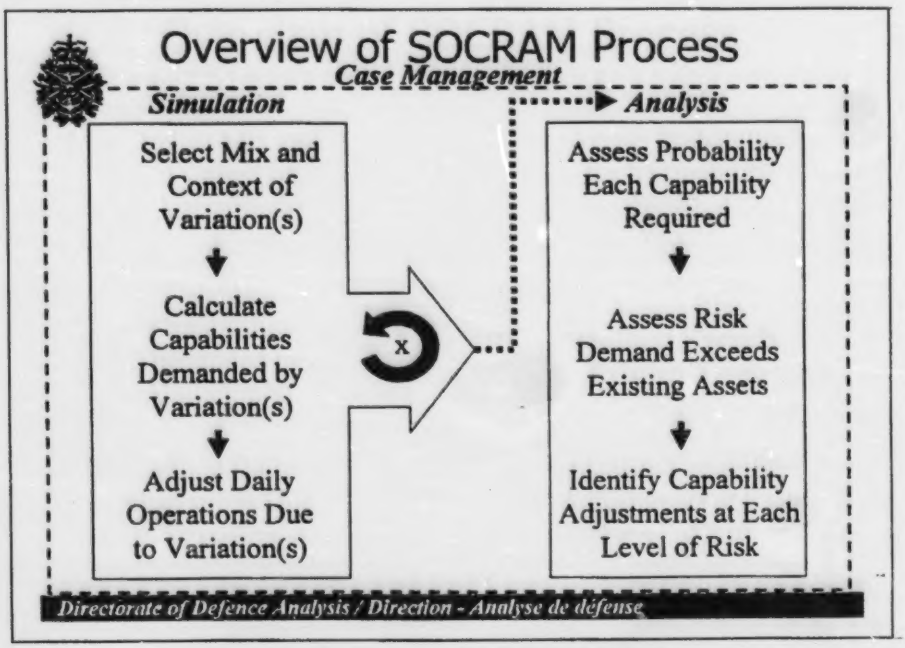


Slide 5 : Pareto Diagram Of The # Of Scenarios Activated

18. The impact of rare outcomes becomes clearer if we take a more detailed view of the full-scale eleven scenario case. As the slide confirms, for virtually all practical cases, only a low number of scenarios are activated simultaneously. In fact, the activation of only 6 of 11 scenarios involves a miniscule chance of over one in 4000. The chances become progressively more rarified up to the extreme case of 11 simultaneous scenarios which involves a phenomenally slim chance of one in 185 billion!

19. Since the practical situation clearly involves a focus on the activation of a low number of scenarios, the logical basis exists to develop a method designed to extensively sample the probabilistic distribution of scenario activation and calculate the corresponding demand. This evidence can then be used to specify the distribution of capability demands. Subsequent analysis can then rely upon this distribution to consider risk of failure for different combinations of assets.

OVERVIEW OF SOCRAM

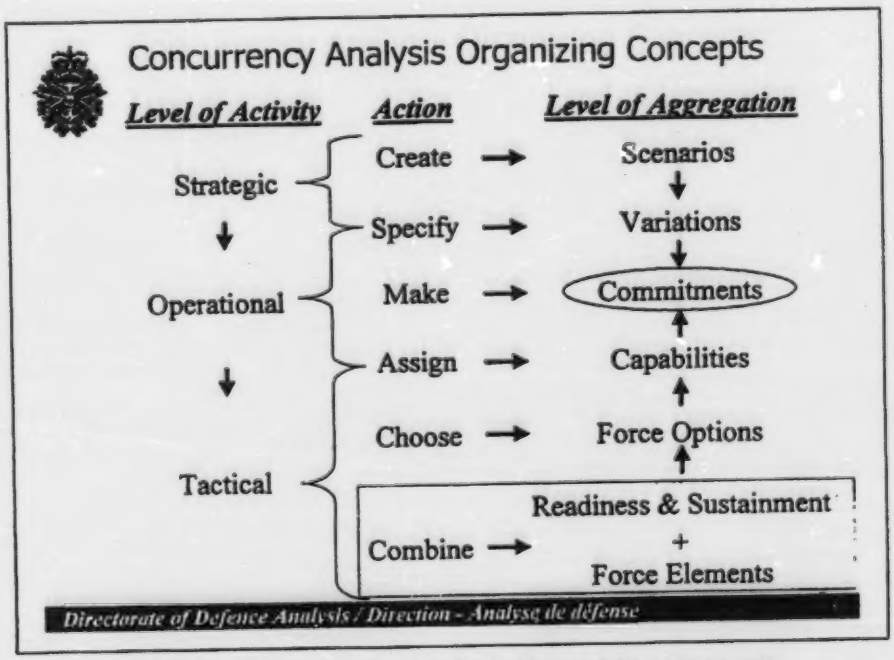

Overview of SOCRAM Process
Case Management
Simulation
Analysis
Select Mix and Context of Variation(s)
Calculate Capabilities Demanded by Variation(s)
Adjust Daily Operations Due to Variation(s)
x
Assess Probability Each Capability Required
Assess Risk Demand Exceeds Existing Assets
Identify Capability Adjustments at Each Level of Risk
Directorate of Defence Analysis / Direction - Analyse de défense

Slide 6 : Overview Of SOCRAM Process

20. The SOCRAM process is implemented through a stochastic simulation designed to mimic probabilistic combinations of scenario conditions. This forms the basis of calculating the resulting total capability demand for each iteration. The analysis framework also caters for explicit handling of the uncertainty of estimates and portrayal of results.

21. SOCRAM is split into three major modules; case management to organise the data, the simulation of possible situations and analysis of the results so they can be used effectively. The display and mechanics employed by the Excel spreadsheet and Visual Basic (VB) applications appear to be quite different but in reality they both use the same underlying principles. The major difference is that Excel segregates case data in different spreadsheets whereas VB administers cases in a single database within a single application.

22. The simulation portion of SOCRAM involves three major steps. Each iteration involves the activation of a specific mix of scenarios and variations from which capability demands are calculated and adjustments applied to daily operations. The results are accumulated into a data file that the analysis module sorts through to determine the probability each capability is demanded. The net demand is bounced against available assets to propose adjustments to ensure a given level of risk is not exceeded.

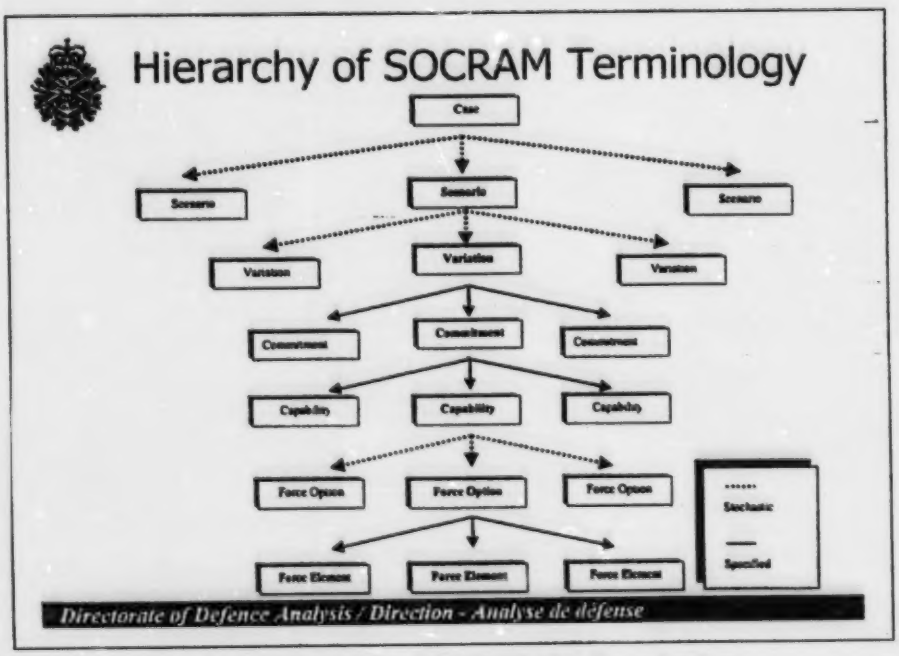


Slide 7 : Concurrence Analysis Organizing Concepts

23. Much of the planning scenario debate heretofore has focused on the philosophical discussion of what capability really means. Unfortunately, this does very little to help progress the development of practical quantitative methodologies. SOCRAM side-steps definitional issues and instead makes a conscious effort to ensure the mechanisms developed will support any capability definition that eventually results.

24. The first step in building a viable concurrence analysis was to put together a conceptual framework that logically links scenarios to distinct operational entities. A special aspect of this was the inclusion of mechanisms to assess special dependencies created by the concentration of multiple capabilities on a single platform or the synergism created by a group of platforms.

25. The slide provides an overview of how these linkages come together for practical purposes in a given case. The strategic level activity starts with the creation of scenarios that are specified as variations covering off specific activation circumstances. The operational level uses these as the basis for making commitments that are then satisfied by assigning a mix of capabilities to achieve the objective. The tactical level perspective of capability involves selecting force elements that are made up of a combination of resources maintained at a planned level of readiness and sustainment.

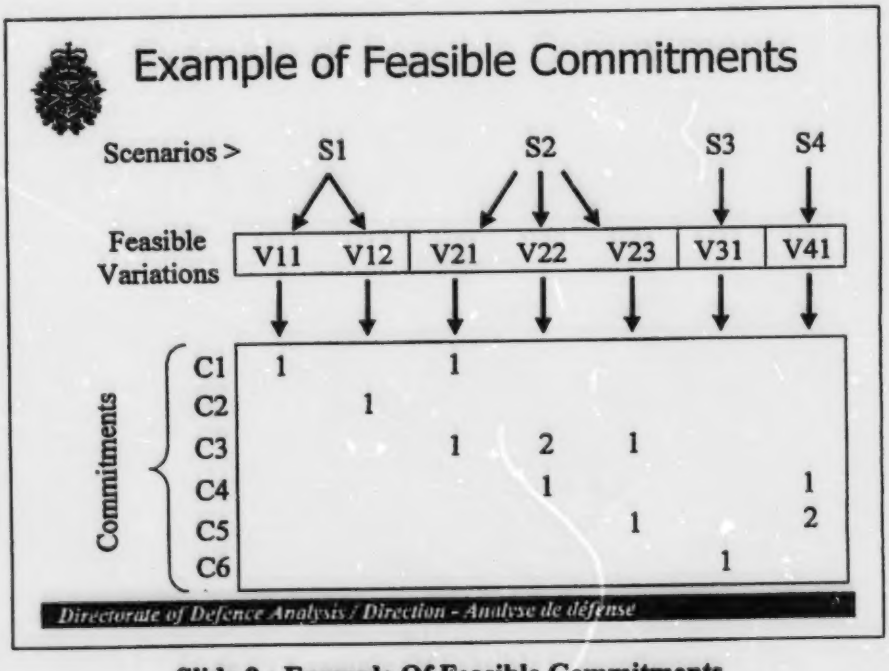


Slide 8 : Hierarchy Of SOCRAM Terminology

26. OCRAM terminology used in the conceptual framework can easily become very confusing. The slide provides a another view of the SOCRAM terminology using a hierarchy view. Take note of the type of linkage that exists between each level.

27. The most significant aspect is that stochastic linkages exist at three different levels. The top two levels involving scenarios and their variations determine the specific set of conditions under which commitments are made and capabilities are activated. The lower stochastic linkage relates capability to the viable combinations of force elements through force options. The force option level is very important because it is the level that enables capability requirements to be converted into potential force structures.

EXAMPLE OF HOW CAPABILITY IS CALCULATED



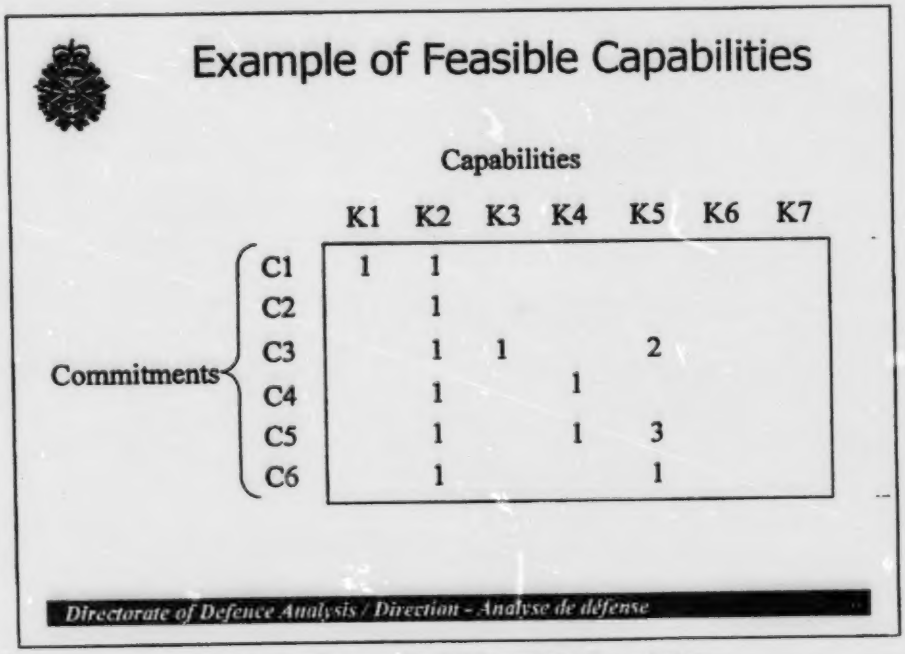
Slide 9 : Example Of Feasible Commitments

28. Implementing the conceptual framework described earlier may appear to be a very esoteric affair but in truth it is actually quite a straightforward thing to implement. However, rather than force the casual observer to swallow it whole, it is worthwhile to identify key issues by working through a simplified "toy" problem that follows.

29. The slide displays a simple case involving four (4) scenarios composed of seven (7) variations between them. Each variation invokes one or more of the six (6) commitments.

30. The interesting thing about the resulting commitment matrix is that it can be used to identify cases where different variations in different scenarios call up common commitments. The opposite situation can also hold when two variations in the same scenario have no common thread in terms of the type of commitments that are activated.

31. Not shown here is a SOCRAM feature that allows the planners to impose limits on what combinations of scenarios or variations are deemed to be feasible. These occur when the business rules (i.e. defence policy) exclude, *a priori*, certain theoretic combinations. The graphs that follow are based upon this reduced set of feasible combinations but the specific set precluded is not important to the discussion of this example. Suffice to say, the planner has the mechanism to modify theory to keep it in line with practice.



Slide 10 : Example Of Feasible Capabilities

32. Commitments (C1 - C6) are used to activate capabilities (K1 – K7). They are related to each other through a second transformation matrix shown in the slide. An important attribute of this matrix is that individual commitments can call up any combination of capabilities. In this example, K1 is only tapped once by C1 and K3 is only tapped once by

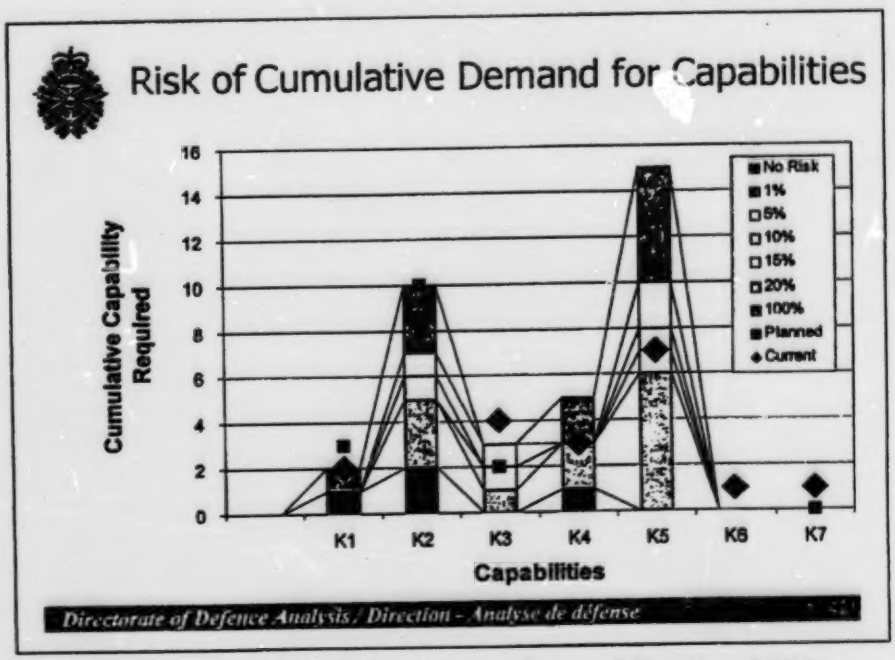
C3 while K4 and K5 are called upon by more than one commitment. Capability K2 is quite unique because it is activated by all commitments. Capabilities K6 and K7 exist but have no associated demand.

33. The cumulative capability requirements (K_T) are based on the combinations of capabilities (K_l) called up by variations (Vj) within given scenarios (S_i), and the commitments (C_k). The formulation of this is nothing more than:

$$K_T = \Sigma (Vj \mid S_i * C_k * K_l)$$

34. A similar matrix to the above specifies the cumulative capability utilized in daily operations and the percentage of that can be activated whenever a variation is activated.

PRESENTATION OF CAPABILITY RESULTS



Slide 11 & 12 : Risk Of Cumulative Demand For Capabilities

35. Once the chain of factors have been multiplied together, it is a simple case to accumulate the data for each capability and then determine the percentage of time (i.e. risk) that a given level of demand is exceeded.

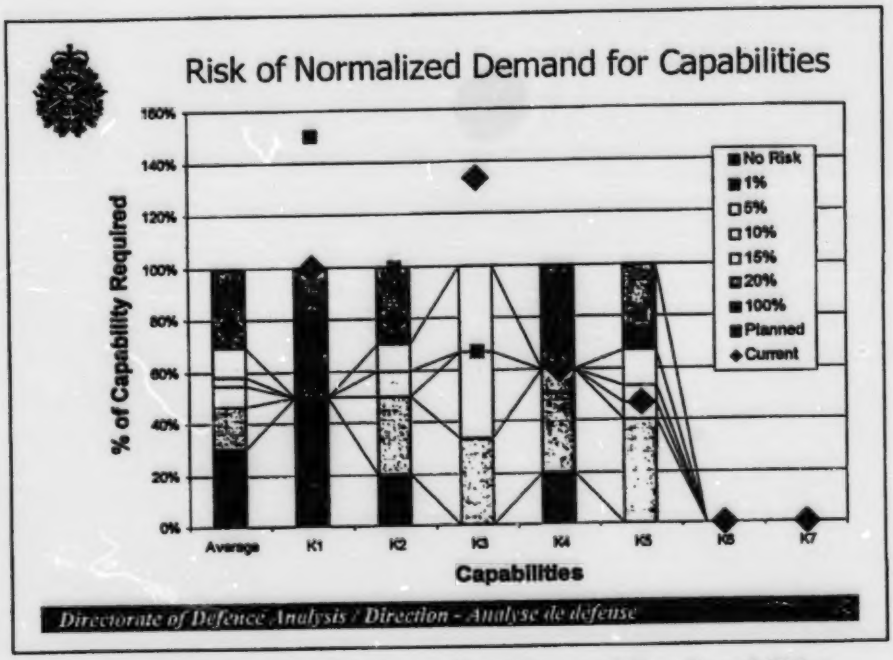
36. Once the risk is associated with demand, the next logical step is to graph the results on a chart such as the slide above. In this example, the toy problem results are rolled up for each capability. It is quite evident from the displayed patterns that each capability has an unique distribution of demand. This non-linearity arises, in part, because the scenario demand can also generate a reduction to daily operations demand. The net impact is that some or all of the scenario demand may be satisfied through offsets in other activities rather than having to rely solely on new demand.

37. Also note that the minimum risk level used in this example is set to a nominal 1% level because of the relatively small number of iterations used in the spreadsheet simulation. The "No Risk" situation is properly catered for in the VB application version by a special feature, that, when invoked, ensures all scenario and variation permutations will be explicitly calculated at least once.

38. If we look closely at K2 we see that its minimum demand (i.e. risk of 100%) is one because K2 is used on a daily basis and is activated by every commitment. In order to reduce the risk to 20% we need to have 5 units of K2. The risk can then be halved to 10% if we add one more unit of K2 and halved again (to 5%) with another unit. "Eliminating" the remaining risk requires 3 more units to a total of 10 units of demand.

39. Once the demand has been articulated it is a simple matter to compare it to the current and planned levels of capability. In the case of K2 the current level of 8 units has a risk associated with it slightly below 5%. The planned addition of two more units "eliminates" this risk.

40. The capability K2 is a simple and logical accumulation of evidence that leads to a sensible resolution of the capability gap. The other capabilities illustrate situations where the adjustments have been illogically applied. For instance, K1 involves the situation where the current assets are sufficient but one unit is added nevertheless. The K3 situation involves the unnecessary draw-down of assets beyond the optimum to a point of 15% risk. K4 fails to address a gap of 20% whatsoever while K5 addresses most of the gap but is three short of eliminating the gap. Capabilities K6 and K7 exist but have no associated demand.



Slide 13 & 14 : Risk Of Normalized Demand For Capabilities

41. As noted previously, the cumulative demand graph provides a clear indication of demand within each capability but lacks a common basis to compare capabilities. Without this ability to assess capabilities there is no way to determine which courses of action are the most efficient use of available resources.

42. The only way to compare capabilities is to "normalize" the demand into a common metric. In this case, the potential list of "equivalent units" is severely limited because capabilities cover the entire span of possibilities. It is possible to postulate a purely artificial equivalent unit but there is no sensible explanation to support it. The only bit of logical commonality found so far arises when we convert capability demand to a percentage of its demand with no risk. The resulting percentage produces a common metric that is conceptually easy to grasp.

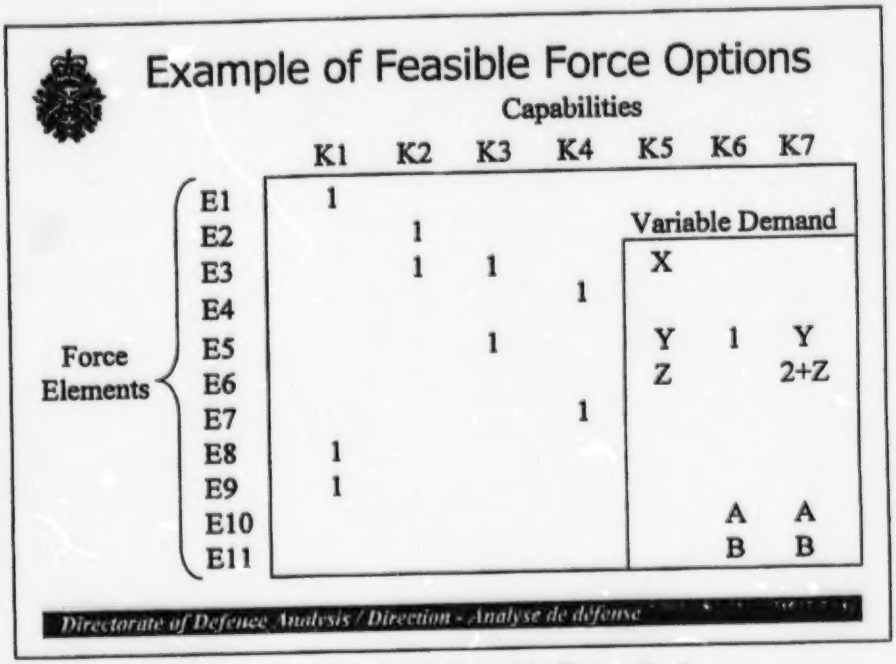
43. One advantage of using the normalized percentage is that it is possible to conduct a statistical analysis. However, the most important implication is that the process of re-aligning capabilities to the same percentage level ensures that resource adjustments can be made efficiently.

44. If we dissect our example problem again using normalized demand we get a much clearer idea of how capabilities relate and what the logical courses of action should be.

45. The use of normalized demand makes it possible to calculate statistics to ascertain the cumulative impact of capability demands and assets. In this example, the arithmetic average of current assets is 77% of the total requirement and imposes about 4% risk. The planned changes improve the capability to 81% but only reduce the risk to about 3%. Note that this average caps the contribution of any asset to 100% since assets that exceed demand clearly add no useful capability.

46. Each capability's level of risk is in proportion to the amount displayed on the cumulative demand graph. However, the normalized demand provides clear and consistence evidence as to what capabilities have the largest divergences from the optimal 100% capability. In this example, it clearly shows that K4 has the most risk (20%) currently and there are no planned capability adjustments to address it. The next most risky current capability is K5 because it imposes a 15% level of risk but an overly zealous planned reduction in excess K3 assets causes K3 to become the second most risky capability bottleneck.

EXAMPLE OF HOW FORCE OPTIONS ARE CALCULATED

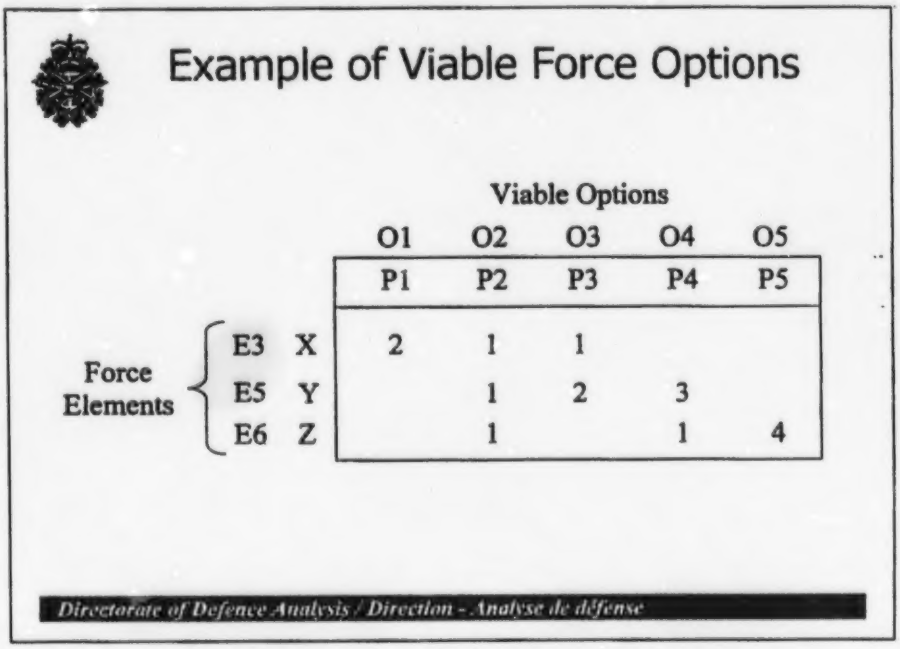


Slide 15: Example Of Feasible Force Options

47. A shortcoming of specifying units of cumulative capability demand is that it provides no direct evidence at this level as to how to allocate resources in order to maximize capability. Capabilities must still be converted to something more tangible.

48. This is accomplished through a third matrix where capabilities (K1 –K7) are related to force elements (E1 - E11). The important attribute of this matrix is that it caters for any combination of capabilities that either relate directly to force elements or exhibit some variability in what is demanded. In this example, the capabilities K1 to K4 activate a specific combination of force elements under all conditions and are therefore are directly related. Meanwhile, K5 to K7 provide a mechanism to activate feasible combinations of force elements. The important factor is that each force element alternative must be scoped so that it either meets or exceeds the mandated capability requirements.

49. The impact of variable demand is to generate a distribution of feasible force options, which allows the planner to consider several alternative force options that relate force elements to required levels of capability. This step also provides the logical basis to consider the implication of capability on different force structures.


Example of Viable Force Options
Viable Options
O1 O2 O3 O4 O5
P1 P2 P3 P4 P5
Force Elements
E3 X 2 1 1
E5 Y 1 2 3
E6 Z 1 1 4
Directorate of Defence Analysis / Direction - Analyse de défense

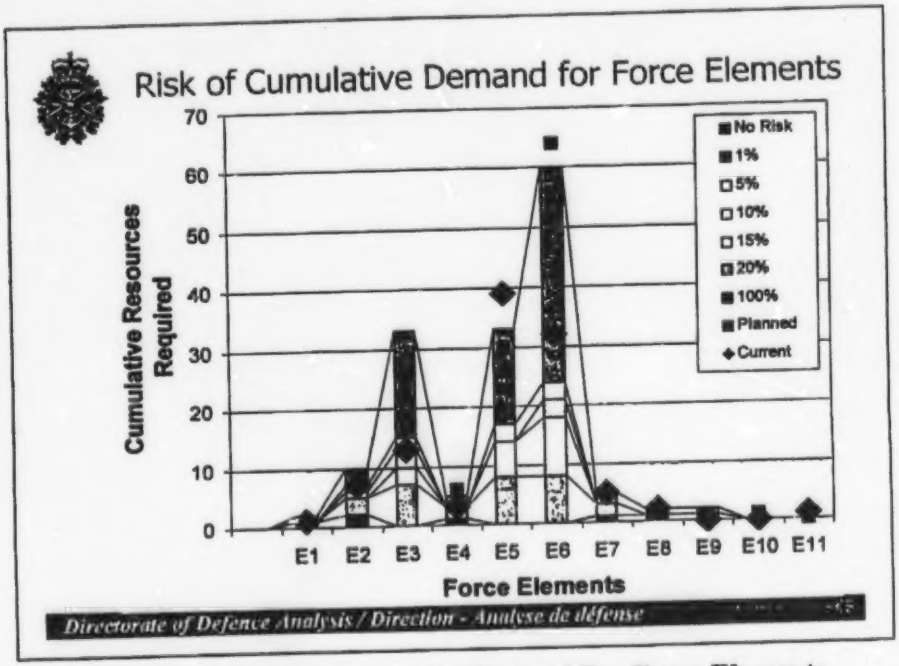
Slide 16 : Example Of Viable Force Options

50. The actual matrix used to relate options to elements is a simple listing of different force element combinations that are activated according to the assigned probabilities. The algorithm uses the probabilities to produce a cumulative distribution function (CDF) which it then samples to select the specific option that relates to a single combination of force elements.

51. The cumulative force elements E_T are based on the feasible combinations of cumulative capability requirements (K_T) combined with force options (O_m), their associated probabilities (P_m) and activated force elements (E_n). This can be displayed as the following equation:

$$E_T = \Sigma (K_T * (P_m * E_n | O_m))$$

PRESENTATION OF FORCE ELEMENT RESULTS

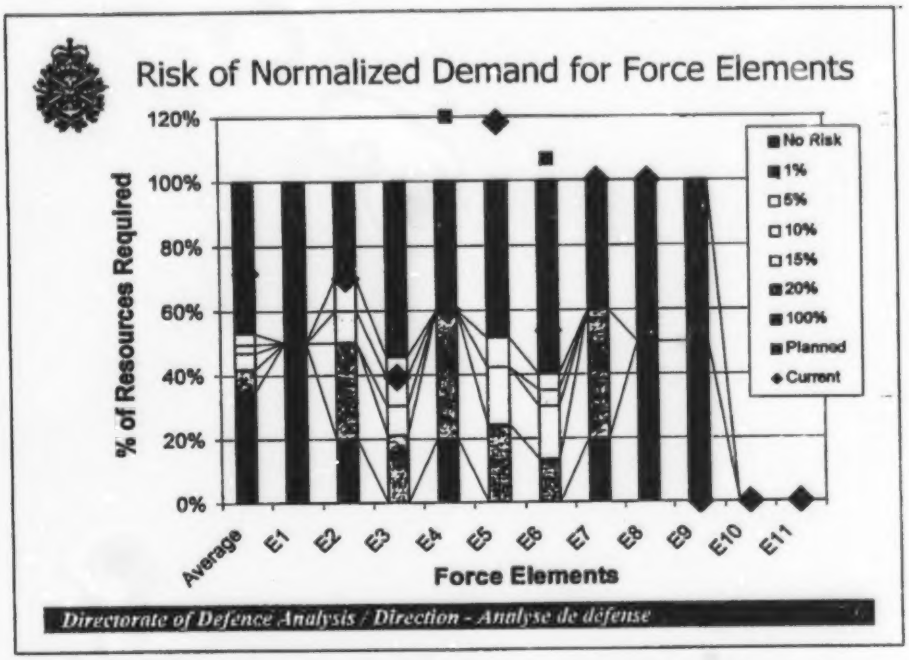


Slide 17 : Risk Of Cumulative Demand For Force Elements

52. The force option conversion from capability to force elements produces results that are very similar to those seen earlier. In fact, the description of the cumulative demand graph for force elements is interpreted precisely the same way as the capability version.

53. There is a potential for two significant major optical differences between the two graphs. Firstly, the number of force elements is expected to increase because there are usually several force element options available that can satisfy the required demand. Secondly, the total units of cumulative demand can easily become very large in a few force elements if they are called upon by multiple variations compared to the others.

54. The result of these factors is that much of the data gets squashed together while only a few force elements appear to dominate due to the large numbers of units. In this example, force elements E3, E4 and E5 have the most units of demand with E3 appearing to have the greatest current shortfall. Each of these factors mitigates towards the preference to focus on the normalized demand graph.



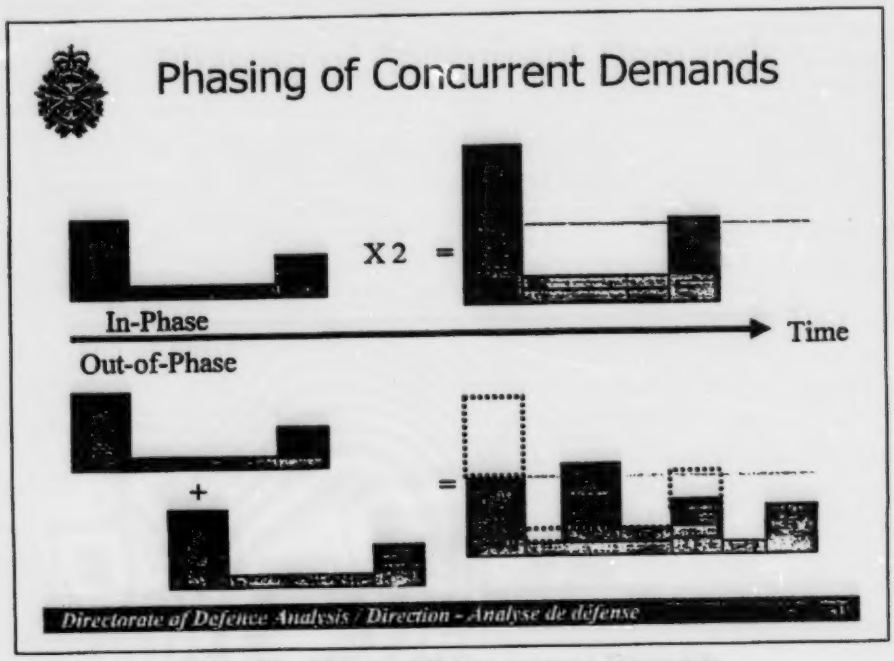
Slide 18 : Risk Of Normalized Demand For Force Elements

55. The normalized demand graph clearly illustrates that several of the current shortfalls are in force elements that the cumulative demand graph could not properly portray for force elements with small levels of demand. In this example, the normalized demand graph clearly illustrates that the most significant current shortfall exists in force element E9 (none with 100% risk) followed by E4 (20% risk) and then E3 (10% risk).

56. The normalized demand graph again draws attention to any foolish adjustments in addressing the number of force elements between current and planned levels. In this example, E5 and E8 have been drawn down too far while E4 and E6 have overshot the maximum demand mark.

57. The most important implication of the normalized demand graph is that it provides a basis for comparing force elements to determine how each one contributes to reducing the overall risk of capability shortfall. This data also provides the basis for converting a given level of risk into its optimal mix of force elements using the normalized demand graph.

FUTURE ISSUES AND INTENTIONS



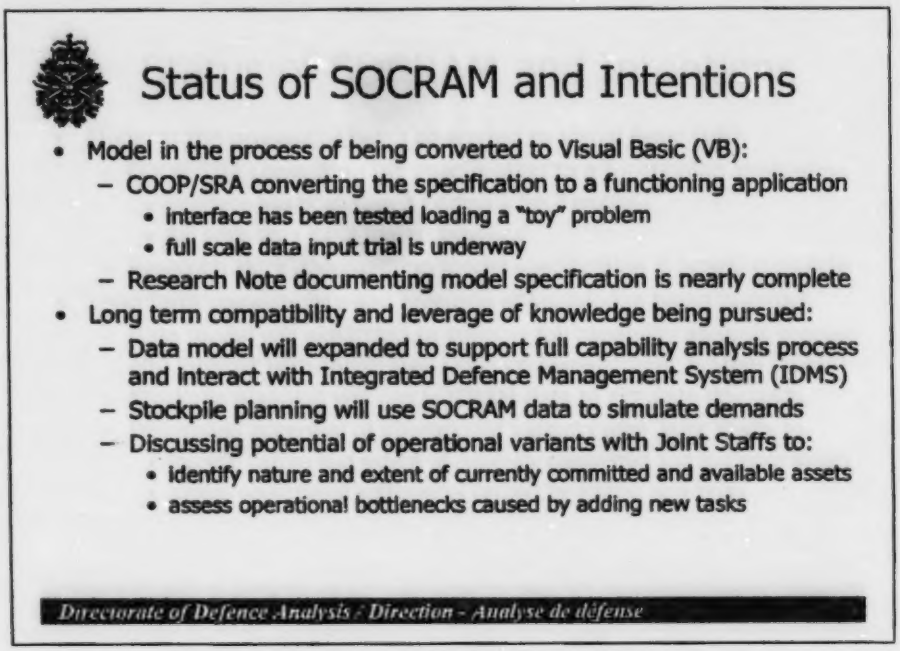
Slide 19 : Phasing Of Concurrent Demands

58. A major assumption behind the current version of SOCRAM is that all concurrent demands occur simultaneously and throughout the tasking. This means that two concurrent demands for the same assets are always fully in-phase with each other. The cumulative demand is fully additive and represents the worst case situation possible.

59. The reality is that very few, if any, demands occur simultaneously and their level of demand is related to some phase(s) of the tasking. The slide provides an example of how the cumulative demand could decrease substantially if the demands are sufficiently out of phase so as to compliment one another.

60. The impact of adjusting SOCRAM has the potential to reduce the cumulative demand in some capabilities and/or force elements. An example of where this can have a profound impact is in strategic airlift because of the dominance of a short deployment surge compared to the in-theatre or redeployment phases.

61. Imposing this new convolution does not undermine any of the SOCRAM concept. The mechanisms needed to implement this feature can be easily accommodated within the existing SOCRAM VB application and will be once the core has been implemented.


Status of SOCRAM and Intentions
• Model in the process of being converted to Visual Basic (VB):
– COOP/SRA converting the specification to a functioning application
• Interface has been tested loading a "toy" problem
• full scale data input trial is underway
– Research Note documenting model specification is nearly complete
• Long term compatibility and leverage of knowledge being pursued:
– Data model will expanded to support full capability analysis process and interact with Integrated Defence Management System (IDMS)
– Stockpile planning will use SOCRAM data to simulate demands
– Discussing potential of operational variants with Joint Staffs to:
• identify nature and extent of currently committed and available assets
• assess operational bottlenecks caused by adding new tasks
Directorate of Defence Analysis / Direction - Analyse de défense

Slide 20 : Status Of SOCRAM And Intentions

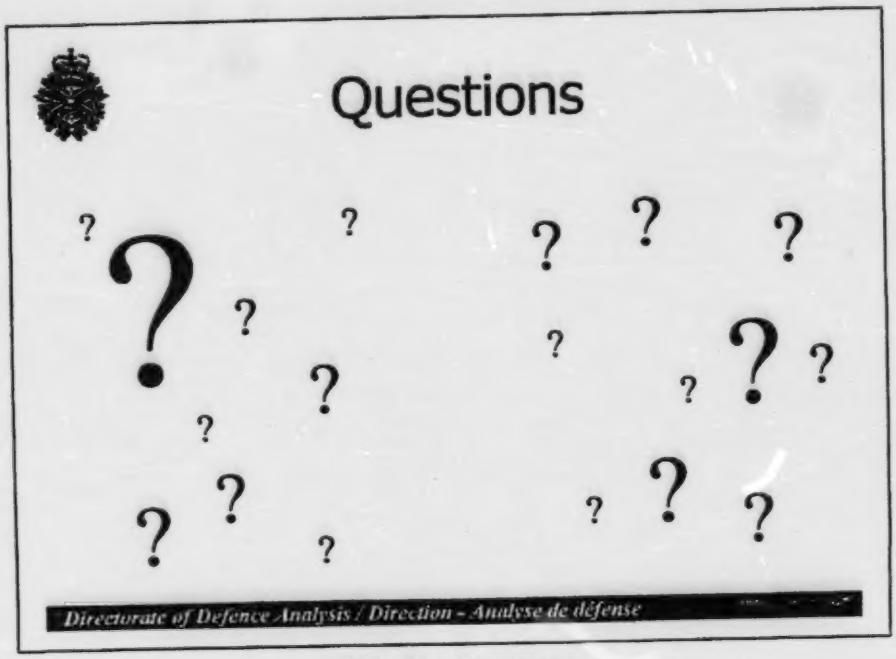
62. The current Excel spreadsheet works but has several programming limitations. The foremost cause is that the OPRAM segmentation of output through a static list of Military Occupation Classifications (MOCs) actually works against SOCRAM because it must support a frequently evolving list of capability and force element groupings.

63. This need is being overcome by re-engineering for a Visual Basic (VB) application operating on top of a relational database. At this point the user interface and simulation have run with the "toy" problem and a full scale trial has started. Meanwhile, the knowledge to date is being captured in a research note that is nearing completion.

64. Several long term compatibility and knowledge leverage opportunities are also being pursued. The most obvious of these is to adapt the relational data model to other Track III models and ensure SOCRAM design compliments IDMS efforts. Stockpile planning will use SOCRAM demand data to drive their marginal analysis models.

65. Other collateral uses of SOCRAM are also anticipated such as the Joint Staff who could use it to help identify the cumulative impact of current commitments and remaining assets. This would provide a sound starting point for assessing the operational bottlenecks caused by adding new tasks.

CONCLUSIONS



Slide 21 : Questions

66. This presentation records development work and helps to serve as part of the corporate scientific memory of the directorate. The contents do not necessarily reflect the view of ORD or the Canadian Department of National Defence.

67. Questions are welcome and can be directed to:

Mr. Ronald W. Funk

Strategic Planning Operational Research Team (SPORT)
Directorate of Defence Analysis (DDA 2-3)
Director General Strategic Planning (DGSP)

National Defence Headquarters

Major-General George R. Pearkes Building
Ottawa, Ontario, Canada
K1A 0K2

(613) 996-2579
Fax (613) 992-5484
Email: funk@ora.dnd.ca

UNCLASSIFIED
SECURITY CLASSIFICATION OF FORM
(highest classification of Title, Abstract, Keywords)

DOCUMENT CONTROL DATA
(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATOR (the name and address of the organization preparing the document. Organizations for whom the document was prepared e.g. Establishment Sponsoring a contractor's report, or tasking agency, are entered in Section 8).

Operational Research Division
Department of National Defence
Ottawa, Ontario K1A 0K2

2. SECURITY CLASSIFICATION (overall security classification of the document, including special warning terms if applicable)

UNCLASSIFIED

3. TITLE (the complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S, C or U) in parentheses after the title)

SCENARIO OPERATIONAL CAPABILITY RISK ASSESSMENT MODEL (SOCRAM) – PRESENTATION TO CANADIAN OPERATIONAL RESEARCH SOCIETY (CORS) CONFERENCE '99 AT WINDSOR ONTARIO, 8 JUNE 1999

4. AUTHOR (last name, first name, middle initial)

FUNK, RONALD W

5. DATE OF PUBLICATION (month Year of Publication of document)

OCTOBER 1999

6a. NO OF PAGES (total containing information. Include Annexes, Appendices, etc.)

27

6b. NO OF REFS (total cited in document)

-

7. DESCRIPTIVE NOTES (the category of document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)

RESEARCH NOTE

8. SPONSORING ACTIVITY (the name of the department project office or laboratory sponsoring the research and development. Include the address).

VICE CHIEF DEFENCE STAFF

9a. PROJECT OR GRANT NO. (if appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant.)

9b. CONTRACT NO. (if appropriate, the applicable number under which the document was written.)

10a. ORIGINATOR's document number (the official document number by which the document is identified by the originating activity. This number must be unique to this document.)

DOR(J&L) RESEARCH NOTE RN 9914

10b. OTHER DOCUMENT NOS. (Any other numbers which may be assigned this document either by the originator or by the sponsor.)

11. DOCUMENT AVAILABILITY (any limitations on further dissemination of the document, other than those imposed by security classification.)

(X) Unlimited distribution
( ) Distribution limited to defence departments and defence contractors: further distribution only as approved
( ) Distribution limited to defence departments and Canadian defence contractors; further distribution only as approved
( ) Distribution limited to government departments and agencies; further distribution only as approved
( ) Distribution limited to defence departments; further distribution only as approved
( ) Other (please specify):

12. DOCUMENT ANNOUNCEMENT (any limitation to the bibliographic announcement of this document. This will normally correspond to the Document Availability (11). However, where further distribution (beyond the audience specified in 11) is possible, a wider announcement audience may be selected.)

13. ABSTRACT (a brief and factual summary of the document. It may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall begin with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (S), (C), or (U). It is not necessary to include here abstracts in both official languages unless the test is bilingual).

One of the major tasks in developing the Scenario-Based Capability-Planning Framework in the Strategic Planning Operational Research Team (SPORT) is to ensure the rigorous activation of concurrent events. After a review of methodologies it was decided to pursue the development of the Scenario Operational Capability Risk Analysis Model (SOCRAM), a discrete event simulation to assess the cumulative demand imposed by the distribution of activated scenarios.

This report covers the content of a background briefing on SOCRAM that was given to the Canadian Operations Research Society Conference at Windsor Ontario on 8 June 1999. It also serves as one of the documents recording the developmental history of a component of the Force Planning Scenario Framework.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus-identified . If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

SCENARIO OPERATIONAL CAPABILITY RISK ASSESSMENT MODEL
SOCRAM
FORCE PLANNING SCENARIOS
DISCRETE EVENT
SIMULATION